

The Regolith Biter: A Divide-And-Conquer Architecture for Sample Return Missions

Completed Technology Project (2012 - 2013)

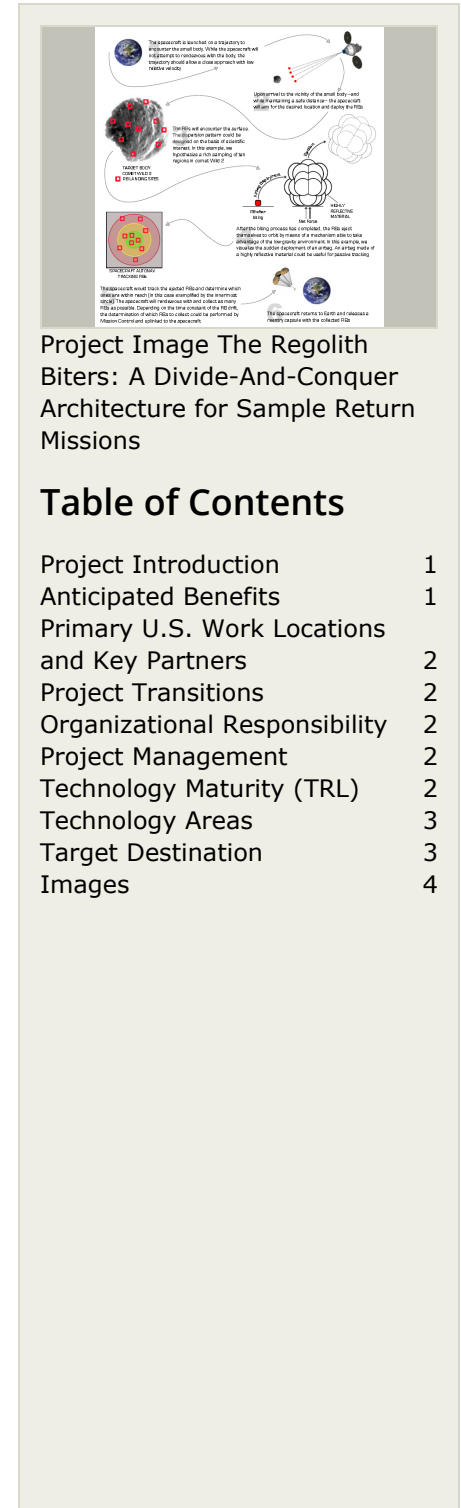


Project Introduction

Asteroid Sample Return mission architecture study, with a flyby mothership releasing small sample takers, called Regolith Biter (RBs). After flyby, the RBs would rendezvous with the mothership to return to Earth. A spacecraft carrying a number of Regolith Biter (RBs) would travel to the vicinity of a small body. From a favorable vantage point, and while remaining within a safe distance in a non-colliding trajectory, it would release the RBs towards the target body. Upon encountering the body, they would bite the regolith (thus retaining a sample), and eject back to orbit. The spacecraft, being endowed with appropriate navigation and tracking capabilities, would rendezvous with and collect those RBs within its reach, and bring them back to Earth. Separating the navigation and sampling concerns removes the need for proximity operations with the small body--the stage in current architectures that carries the most challenges and risks. Eliminating the need for proximity operations brings back to the discussion the exploration of exciting prospects, like highly active comets, fast-rotating bodies, and binary systems. Distributing the sampling problem among a collective of agents provides the opportunity to sample multiple regions in a single mission. It also provides robustness to various environmental conditions, and may enable the distributed, in situ characterization of the body. In the search for reliability, current architectures rely on complexity: an elaborate system should succeed at once. We rely on numbers: a given agent may fail at any stage, but success is attained by the collective.

Anticipated Benefits

This concept is fundamentally different from existing alternatives because it is based on the premise that separating the navigation problem from the sample collection problem will lead to a more robust and exible overall system.



Project Image The Regolith Biter: A Divide-And-Conquer Architecture for Sample Return Missions

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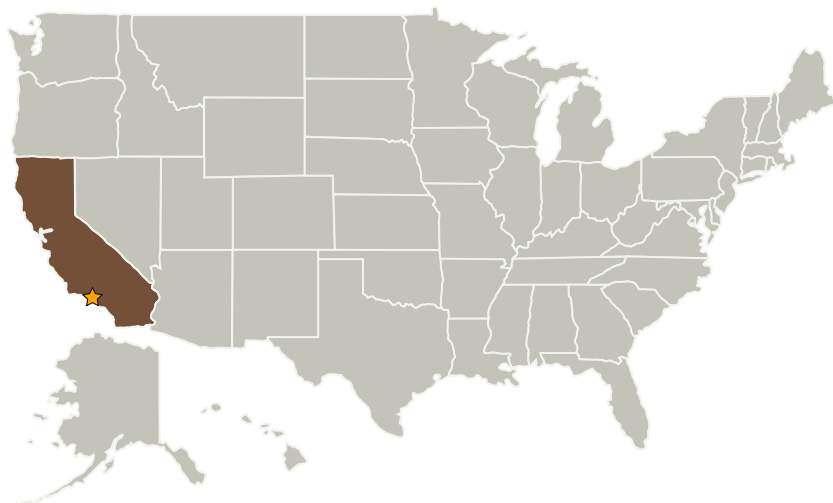
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Jet Propulsion Laboratory (JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

California

Project Transitions

**September 2012:** Project Start

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

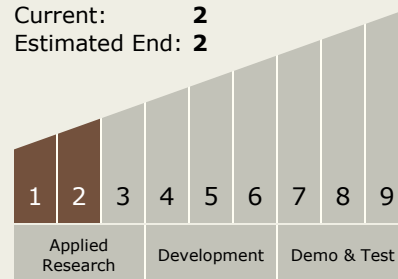
Program Manager:

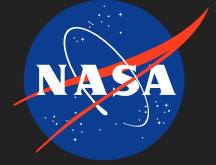
Eric A Eberly

Principal Investigator:

Juan Arrieta

Technology Maturity (TRL)

Start: **1**Current: **2**Estimated End: **2**



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✓ **June 2013:** Closed out

Closeout Summary: The concept investigated consists of a space mission architecture for collecting multiple, distributed samples from small, primitive celestial bodies (like asteroids and comets) and bringing them back to Earth for their study; It is fundamentally different from existing alternatives because it is based on the premise that separating the navigation problem from the sample collection problem will lead to a more robust and flexible overall system. The current architectural paradigm for sample-return missions is centered around a design where spacecraft and sampling device are merged into a single, complex system; we argue that this monolithic approach couples the navigation and sample-collection problems, making both more difficult. We diverge from this vision, and propose a decoupled system-based on the coordinated interaction between a spacecraft and a collective of small, simple devices, which we have called the Regolith Biter s(RBs). A spacecraft carrying a number of RBs would travel to the vicinity of a small body. From a favorable vantage point, and while remaining at a safe distance on a non-colliding trajectory, it would release an approach stage capable of delivering the RBs towards the target body. Upon encountering the body, the RBs would bite the regolith (thus retaining a sample), and eject back to a heliocentric orbit. The spacecraft, being endowed with appropriate propulsion, navigation and tracking capabilities, would rendezvous with and collect those RBs within its reach, and bring them back to Earth. Separating the navigation and sampling concerns could remove the need for proximity operations with the small body---the stage in current architectures that carries the most challenges and risks. Eliminating the need for small body proximity operations brings back to the discussion the exploration of exciting prospects like highly active comets, fast-rotating bodies, and binary systems. In addition, distributing the sampling problem among a collective of agents could provide the opportunity to sample multiple regions ---on one or multiple bodies within a system - in a single mission. It may also provide robustness to various environmental conditions, and enable the distributed, in-situ characterization of the small body. These technical distinctions separate our concept from existing art.

Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
 - └ TX17.2 Navigation Technologies
 - └ TX17.2.1 Onboard Navigation Algorithms

Target Destination

Others Inside the Solar System

The spacecraft is launched on a trajectory to investigate the small body. While the spacecraft will be oriented to rendezvous with the body, the trajectory should allow a close approach with low relative velocity.

The flybys will encounter the surface. The observation pattern should be designed on the basis of scientific interest. In the example, we highlight a rich sampling of ring regions in central VES.

Upstream to the vicinity of the small body - and while maintaining a safe distance - the spacecraft will aim for the desired location and deploy the FIBs.

After the testing process has completed, the FIBs assist themselves to orbit the means of a magnetron able to seize subobjects of the two-point environment. In this manner, we visualize the superior deployment of an array. An array made of a highly reflective material could be used for passive tracing.

The Spacecraft returns to Earth and releases a recovery capsule with the collected FIBs.

Project Image The Regolith Biter:
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for Sample Return Missions
(<https://techport.nasa.gov/image/102329>)